METHOD AND APPARATUS FOR SEGMENTED PEER-TO-PEER COMPUTING

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention relates generally to an improved data processing system, and in particular to a method and apparatus for processing data. Still more particularly, the present invention provides a method, apparatus, and computer implemented instructions for peer-to-peer computing.

2. Description of Related Art:

The Internet, also referred to as an "internetwork", is a set of computer networks, possibly dissimilar, joined together by means of gateways that handle data transfer and the conversion of messages from a protocol of the sending network to a protocol used by the receiving network. When capitalized, the term "Internet" refers to the collection of networks and gateways that use the TCP/IP suite of protocols.

The Internet has become a cultural fixture as a source of both information and entertainment. Many businesses are creating Internet sites as an integral part of their marketing efforts, informing consumers of the products or services offered by the business or providing other information seeking to engender brand loyalty. Many federal, state, and local government agencies are also employing Internet sites for informational purposes, particularly agencies which must interact with virtually all segments of society such as the Internal Revenue Service and secretaries of state. Providing informational guides and/or searchable databases of online public records may reduce operating costs. Further, the Internet is becoming increasingly popular as a medium for commercial transactions.

Currently, the most commonly employed method of transferring data over the Internet is to employ the World Wide Web environment, also called simply "the Web". Other Internet resources exist for transferring information, such as File Transfer Protocol (FTP) and Gopher, but have not achieved the popularity of the Web. In the Web environment, servers and clients effect data transaction using the Hypertext Transfer Protocol (HTTP), a known protocol for handling the transfer of various data files (e.g., text, still graphic images, audio, motion video, etc.). The information in various data files is formatted for presentation to a user by a standard page description language, the Hypertext Markup Language (HTML). In addition to basic presentation formatting, HTML allows developers to specify "links" to other Web resources identified by a Uniform Resource Locator (URL). A URL is a special syntax identifier defining a communications path to specific information. Each logical block of information accessible to a client, called a "page" or a "Web page", is identified by a URL. The URL provides a universal, consistent method for finding and accessing this information, not necessarily for the user, but mostly for the user's Web "browser". A browser is a program capable of submitting a request for information identified by an identifier, such as, for example, a URL. A user may enter a domain name through a graphical user interface (GUI) for the browser to access a source of content. The domain name is automatically converted to the Internet Protocol (IP) address by a domain name system (DNS), which is a service that translates the symbolic name entered by the user into an IP address by looking up the domain name in a database.

The standard computing structure on the Web is that of a classic client-server network. Requests for information are sent from clients to a server. The server, in turn, processes the request and returns a reply, which may be a Web page or a file. A newer architecture used on the Web is a peer-to-peer network. A peer-to-peer network is a communications network that allows all workstations and computers in the network to act as servers to all other users on the network. Dedicated file servers may be used, but are

not required as in a client/server architecture. This type of network architecture does not solve a problem in which two or more distinct groups of users desire to transfer information or communicate only with those outside of their group. For example, with job seekers and employers, many job seekers only want to communicate with employers and not other job seekers. Similarly, employers desire to communicate with job seekers and not other employers.

Therefore, it would be advantageous to have an improved method and apparatus for managing communications within a peer-to-peer network data processing system.

SUMMARY OF THE INVENTION

The present invention provides a method, apparatus, and computer implemented instructions for managing processing of data in data processing system within a peer-to-peer network data processing system. A request is received from a requestor. Preferences are compared within the request to control information to form a comparison, in which the control information dictates responses by the data processing system. The request is selectively responded to based on comparison.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is a pictorial representation of a network of data processing systems in which the present invention may be implemented;

Figure 2 is a block diagram illustrating a data processing system in which the present invention may be implemented;

Figure 3 is a diagram of a peer-to-peer network data processing system in accordance with a preferred embodiment of the present invention;

Figure 4 is a diagram of components used for peer-to-peer computing in accordance with a preferred embodiment of the present invention;

Figure 5 is a diagram illustrating a request from a node in a peer-to-peer network data processing system in accordance with a preferred embodiment of the present invention;

Figures 6A and **6B** are diagrams illustrating a profile and a request in accordance with a preferred embodiment of the present invention;

Figure 7 is a flowchart of a process used for generating a request in a peer-to-peer network data processing system in accordance with a preferred embodiment of the present invention;

Figure 8 is a flowchart of a process used for processing a request in a peer-to-peer network data processing system in accordance with a preferred embodiment of the present invention;

Figure 9 is a flowchart of a process used for changing membership in a group in a peer-to-peer network data processing system in accordance with a preferred embodiment of the present invention; and

Figure 10 is a flowchart of a process used for reviewing membership in a group in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures, **Figure 1** depicts a pictorial representation of a network of data processing systems in which the present invention may be implemented. Network data processing system **100** is a network of computers in which the present invention may be implemented. Network data processing system **100** contains a network **102**, which is the medium used to provide communications links between various devices and computers connected together within network data processing system **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables. Network data processing system **100** may support both client/server and peer-to-peer computing systems.

In the depicted example, work station **104** is connected to network **102** along with storage unit **106**. In addition, work stations **108**, **110**, and **112** are connected to network **102**. These work stations also are referred to as nodes, These work stations **108**, **110**, and **112** may be, for example, personal computers or network computers. In the depicted example, these data processing system communicate with each other in a peer-to-peer fashion. The present invention provides a method, apparatus, and computer implemented instructions for in which these work stations are able facilitate communications between two or more groups of nodes in which a node in a group desires to communicate only with nodes outside of the group to which the node belongs. For example, with job seekers and employers, job seeker nodes do not communicate with them selves, but only with communicate with employer nodes. The mechanism for enabling this feature is described in more detail below.

Network data processing system **100** may include servers, clients, and other devices not shown. In the depicted example, network data processing system **100** is the

Internet with network **102** representing a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. At the heart of the Internet is a backbone of high-speed data communication lines between major nodes or host computers, consisting of thousands of commercial, government, educational and other computer systems that route data and messages. Of course, network data processing system **100** also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN).

In an additional example, data processing system **100** may be implemented as or include a wireless network. For example, a Bluetooth wireless network may be used in the peer-to-peer computing system of the present invention. Bluetooth is a wireless personal area network (PAN) technology from the Bluetooth Special Interest Group. Bluetooth is an open standard for short-range transmission of digital voice and data between mobile devices (laptops, PDAs, phones) and desktop devices. Bluetooth supports point-to-point and multipoint applications. A Bluetooth radio is built into a small microchip and operates in a globally available frequency band ensuring communication compatibility worldwide. A tiny Bluetooth microchip, incorporating a radio transceiver, is built into digital devices. Bluetooth technology makes all connections quickly and without the need for cable. The radio operates in a globally available frequency band, ensuring compatibility worldwide. Bluetooth facilitates fast and secure transmission of both voice and data, even when the devices are not within line of sight. Bluetooth technology supports both point-to-point and point-to-multipoint connections. Bluetooth has a nominal link range is up to 10 meters.

Currently, up to seven 'slave' devices can be set to communicate with a 'master' radio in one device. Several of these 'piconets' can be established and linked together in ad hoc 'scatternets' to allow communication among continually flexible configurations. All devices in the same piconet have priority synchronization, but other devices can be set

to enter at any time. The topology can best be described as a flexible, multiple piconet structure. **Figure 1** is intended as an example, and not as an architectural limitation for the present invention.

With reference now to **Figure 2**, a block diagram illustrating a data processing system is depicted in which the present invention may be implemented. Data processing system **200** is an example of a node, such as, for example, work station **104** in **Figure 1**. Data processing system **200** employs a peripheral component interconnect (PCI) local bus architecture. Although the depicted example employs a PCI bus, other bus architectures such as Accelerated Graphics Port (AGP) and Industry Standard Architecture (ISA) may be used. Processor **202** and main memory **204** are connected to PCI local bus **206** through PCI bridge **208**. PCI bridge **208** also may include an integrated memory controller and cache memory for processor **202**. Additional connections to PCI local bus **206** may be made through direct component interconnection or through add-in boards. In the depicted example, local area network (LAN) adapter **210**, SCSI host bus adapter **212**, and expansion bus interface **214** are connected to PCI local bus **206** by direct component connection. In contrast, audio adapter **216**, graphics adapter **218**, and audio/video adapter **219** are connected to PCI local bus **206** by add-in boards inserted into expansion slots. Expansion bus interface **214** provides a connection for a keyboard and mouse adapter **220**, modem **222**, and additional memory **224**. Small computer system interface (SCSI) host bus adapter **212** provides a connection for hard disk drive **226**, tape drive **228**, and CD-ROM drive **230**. Typical PCI local bus implementations will support three or four PCI expansion slots or add-in connectors.

An operating system runs on processor **202** and is used to coordinate and provide control of various components within data processing system **200** in **Figure 2**. The operating system may be a commercially available operating system, such as Windows 2000, which is available from Microsoft Corporation. An object oriented programming

system such as Java may run in conjunction with the operating system and provide calls to the operating system from Java programs or applications executing on data processing system **300**. "Java" is a trademark of Sun Microsystems, Inc. Instructions for the operating system, the object-oriented operating system, and applications or programs are located on storage devices, such as hard disk drive **226**, and may be loaded into main memory **204** for execution by processor **202.**

Those of ordinary skill in the art will appreciate that the hardware in **Figure 2** may vary depending on the implementation. Other internal hardware or peripheral devices, such as flash ROM (or equivalent nonvolatile memory) or optical disk drives and the like, may be used in addition to or in place of the hardware depicted in **Figure 2**. Also, the processes of the present invention may be applied to a multiprocessor data processing system.

As another example, data processing system **200** may be a stand-alone system configured to be bootable without relying on some type of network communication interface, whether or not data processing system **200** comprises some type of network communication interface. As a further example, data processing system **200** may be a Personal Digital Assistant (PDA) device, which is configured with ROM and/or flash ROM in order to provide nonvolatile memory for storing operating system files and/or user-generated data.

The depicted example in **Figure 2** and above-described examples are not meant to imply architectural limitations. For example, data processing system **200** also may be a notebook computer or hand held computer in addition to taking the form of a PDA. Data processing system **200** also may be a kiosk or a Web appliance.

With reference now to **Figure 3**, a diagram of a peer-to-peer network data processing system is depicted in accordance with a preferred embodiment of the present invention. Peer-to-peer network data processing system **300** may be implemented within

network data processing system **100** in **Figure 1**. In this example, two groups of nodes are illustrated, group **302** and group **304**. Group **302** contains nodes **306**, **308**, **310**, and **312**, while group **304** contains nodes **314**, **316**, **318**, and **320**. Node **306** includes communications link **322** to node **314**, communications link **324** to node **316**, and communications link **326** to node **320**. Node **308** has communications link **328** to node **316**. Node **310** includes communications link **330** to node **318**. Node **312** includes communications link **332** to node **318** and communications link **334** to node **320**.

As, can be seen in this example, nodes within group **302** only establish communications links with nodes in group **304**. No communications links are present between nodes within the same group. Only two groups are shown in this example for purposes of illustrating the communications between members within a group to members in another group. This type of connection may be applied to other numbers of groups and other numbers of nodes other than those illustrated in **Figure 3**. For example, a peer-to-peer network data processing system may include three groups of nodes: group 1, group 2, and group 3. The nodes in group 1 may communicate only with the nodes in group 2, and the nodes in group 3 may only communicate with the nodes in group 1. In this example, the nodes in group 2 do not communicate with nodes in group 3 or with nodes in group 1.

The establishment of communications links between nodes are governed using a policy in these examples. The policy is a set of rules, which dictate communications with other nodes. All nodes may receive messages broadcast from a first node. Only selected nodes may reply based on the policy implemented at each node.

Turning next to **Figure 4**, a diagram of components used for peer-to-peer computing is depicted in accordance with a preferred embodiment of the present invention. Node **400** may be implemented using data processing system **200** in **Figure 2**. Node **400** includes peer-to-peer processes **402**, which provide the processes used to

generate requests and to handle received requests. These processes may be performed on a node in the peer-to-peer network or may be performed on a separate central processing system associated with the peer-to-peer network that is in communication with the nodes of the network. The processing of requests is performed using information in profile **404** and policy **406**. Profile **404** includes information about the user. Profile **404** may be defined as a set of user preferences. This information may include, for example, dating/social interaction preferences, applicant vs. employer, music or other media preferences, particular expertise, ownership characteristics, interest, geographical location, membership in organization or affinity groups, consumption preferences and purchasing histories, and expertise. This profile information may be used to establish membership in different groups.

Policy **406** provides rules and other information used to determine whether peer-to-peer processes **402** will respond to a request. Policy **406** forms the control information used to determine how a request is to be handled. For example, a job seeker node may receive a request from an employer node looking for job seekers. Although the job seeker node needs the requirements in the response, a response may not be generated if, for example, a match in geographic location for the job is absent. In this case, the request is discarded without a response. Policy **406** also is used to determine whether a node can interact only with members of the same set, only with members not of the same set, or members of different sets. Policy **406** also may contain certificate for use in verifying membership within a group. A certificate is the digital equivalent of an ID card used in conjunction with a public key encryption system. Certificate also are called "digital IDs". Typically, digital certificates are issued by trusted third parties known as certification authorities after verifying that a public key belongs to a certain owner. The certification process varies depending on the certification authorities and the level of certification. Drivers licenses, notarization and fingerprints are examples of

documentation required. The digital certificate is actually the owner's public key that has been digitally signed by the certification authorities. The digital certificate is sent along with an encrypted message to verify that the sender is truly the entity identifying itself in the transmission. The recipient uses the public key of the certification authorities, which is widely publicized, to decrypt the sender's public key attached to the message. Then the sender's public key is used to decrypt the actual message.

Access or verification of a node may be controlled using other mechanisms, such as a password. Membership within a group and access to nodes within the group also could be based on a payment of money or services.

The duration of membership within a group may be permanent or temporary. If temporary, the membership may continue only for a selected period of time or as long as attributes of the user fall within certain values or ranges. These attributes may include, for example, martial status, age, interests, geographic location, and consumption preferences. Membership also may be based on contributions or usage of the peer-to-peer network data processing system.

The interaction between different nodes may be based on services, such as a dating service; an information sharing service; an employment service; a group buying server; and a service for sharing music, books, articles, images, or other media. The interaction between nodes may include various activities, such as, for example, chatting, instant messaging, and e-mail. The interaction also may include an information sharing service, a group buying service, instant messaging, electronic mail, distributing software, distributing software upgrades, or distributing software fixes. This interaction also may include a distribution of intellectual property, such as copyrighted or patented materials. Members in a group may exchange compensation for different interactions. This compensation may take various forms, such as financial, barter, or payment in kind. The compensation may be based on attributes of the interactions, such as, for example, a size

of files transferred, a quality of a good, a quality of a service, a type of good, a type of server, and a member rating.

In one example, the management of payments between different members may be performed using a clearinghouse. The clearinghouse may be, for example, a Web site designed for the exchange of payments. PayPal of Palo Alt, CA, found on the Internet at www.paypal.com, is an example of a clearinghouse.

Turning next to **Figure 5**, a diagram illustrating a request from node in a peer-to-peer network data processing system is depicted in accordance with a preferred embodiment of the present invention. This example, request **500** includes node ID **502**, certificate **504**, profile **506** (i.e., a set of user preferences), and message **508**. Node ID **502** is typically found within a header of request **500** but also may be located elsewhere depending on the particular implementation. Node ID **502** may include an IP address of the node, a user name, or some unique identifier. Certificate **504** is used to verify the identity of an individual or user at the node. Certificate **504** may be associated with an IP address, an e-mail address, or some other unique identifier. Profile **506** contains information about the user at the node. This information is used by a node receiving the request to determine whether to respond to the request.

Next, message **508** contains the particular request being may be the node. This request may include, for example, requesting initiation of a chat session, requesting a resume, requesting a video file, or requesting a document. Message **508** also may identify what groups should respond to the request. For example, the request may ask for employers seeking employees to respond.

When request **500** is received by a node, the peer-to-peer process in the node will determine how the request is handled. Turning now to **Figures 6A** and **6B**, diagrams illustrating a profile and a request are depicted in accordance with a preferred embodiment of the present invention. Profile **600** in **Figure 6A** is an example of user

preference information that may be included in profile **506** in **Figure 5**. Profile **600** identifies the user as an employee having a particular job, education level, and geographic location. In **Figure 6B**, request **602** is an example of a request that may be found with message **508** in **Figure 5**. Request **602** indicates that the user is requesting a response from an employer for a job with a particular geographic location. The employer may be any employer or be specified as a particular type of employer depending on the implementation. The profile and request shown in **Figures 6A** and **6B** are presented for purposes of illustration and are not intended to limit the amount or type of information that may be used.

Turning now to **Figure 7**, a flowchart of a process used for generating a request in a peer-to-peer network data processing system is depicted in accordance with a preferred embodiment of the present invention. The process illustrated in **Figure 7** may be implemented in a data processing system, such as node **400** in **Figure 4**.

The process begins by receiving input for a request from a user (step **700**). Next, profile information is received (step **702**). Thereafter, a certificate is retrieved (step **704**. The certificate is used to authenticate the identity of the user generating the request at the node. A request is generated with the input, certificate, and profile information (step **706**). This request may take the form of request **500** in **Figure 5**. Then, the request is transmitted using the input and profile information (step **708**) with the process terminating thereafter.

With reference now to **Figure 8**, a flowchart of a process used for processing a request in a peer-to-peer network data processing system is depicted in accordance with a preferred embodiment of the present invention. The process illustrated in **Figure 8** may be implemented in a data processing system, such as node **400** in **Figure 4**.

The process begins by receiving a request from a requestor (step **800**). Next, the request is compared to a policy (step **802**). A determination is then made as to whether a

match is present (step **804**). This step may include determining whether the profile information within the request identifies that the requesting node as being a member of a group for which communication is permitted. For example, employers are permitted to communicate with job applicants (employees). Alternatively, the step may include determining that the profile information within the request identifies the requesting node as being a member of a group for which communication is not permitted. For example, employers may not be permitted to communicate with other employers. Additionally, step **804** may include determining whether the node meets the parameters of the request if the requesting node is one in which communications is permitted. For example, the requesting node may be a job seeker seeking an employer having a management job. The node receiving the request may be an employer seeking a job seeker for a programming job. In this instance, the node sending the request is a member of a group in which communications is allowed, but no response is made because the parameter in the request, a management position, is not available.

If a match is present, the request is processed (step **806**). A response is generated (step **808**). The response is then returned to the requestor (step **810**) with the process terminating thereafter. Turning back to step **804**, if no match is present, the request is discarded (step **812**) and the process terminates.

Turning now to **Figure 9,** a flowchart of a process used for changing membership in a group in a peer-to-peer network data processing system is depicted in accordance with a preferred embodiment of the present invention. The process illustrated in **Figure 9** may be implemented in data processing system, such as node **400** in **Figure 4**. Through the process illustrated in **Figure 9**, a member of a group may initiate a vote to include or authorize a new member in the group. Further, a member of the group may vote to exclude a member of the same group or a different group.

The process begins by generating a request to change membership (step **900**).

Next, the request is transmitted to nodes within the peer-to-peer network data processing system (step **902**). In these example, the message is broadcast within the network and those nodes within the network, which are part of the group, will process the request. Other nodes will ignore the request. The node originating the request waits to receive a response (step **904**). The node originating the request will serve as a point to process responses. When a response containing a vote is received, the vote is processed (step **906**). A determination is then made as to whether more responses are expected (step **908**). This may be accomplished by establishing a timeout period for the responses. If no more responses are expected, a determination is made as to whether the vote is passed (step **910**). If the vote does not pass, the process terminates. Otherwise, a message is generated indicating the membership change (step **912**) and a message is transmitted to announce the change in membership within in the group (step **914**) with the process terminating thereafter.

With reference again to step **908** if more responses are expected, a determination is made as to whether a timeout has occurred (step **916**). The timeout is used to end voting and is selected as a period of time during which votes should be received. If a timeout has occurred, the process proceeds to step **910**. If no timeout has occurred, the process returns to step **904** as described above.

Turning now to **Figure 10**, a flowchart of a process used for reviewing membership in a group is depicted in accordance with a preferred embodiment of the present invention. The process illustrated in **Figure 10** may be implemented in data processing system, such as node **400** in **Figure 4**. The process in **Figure 10** is implemented when nodes track members within a group. Nodes may track members by updating, exchanging, and storing membership lists.

The process begins by selecting a member from a membership group (step **1000**). The member is compared to criteria (step **1002**). Next, a determination is made as to

whether the member should have continued membership (step **1004**). If the membership is to be continued, a determination is made as to whether more unprocessed members are present (step **1006**). If there are more unprocessed members are present, the process returns to step **1000** as described above. Otherwise, the process terminates. With reference again to step **1004**, if the membership of the member is not to continue, the member is deleted from the membership group (step **1008**) and the process proceeds to step **1006**.

The duration of membership within the group may be unlimited. Typically, however, the criteria for membership may be based upon different factors, such as, for example, receipt of a payment from a member, a presence of selected attributes, contributions to the peer-to-peer data processing system, and usage of the peer-to-peer data processing system. The selected attributes may include, for example, marital status, age, and interests. Further, the interaction between members in a group may include exchanging compensation for the interactions. These interactions may include, for example, distribution of software, software fixes, and software upgrades. The compensation may take various forms, such as financial, barter, or payment in kind. Payments may be based on various attributes of the interactions, such as size of files transferred, quality of goods or services, type of good or service, and member ratings. The member ratings may be generated using various mechanisms. For example, the ratings may be based on feedback from set members, or from members of other sets. The ratings may be provided by a third party. Alternatively, the ratings may be based on analysis of interactions by group members, including, for example, financial size of transactions and number of successfully completed transactions. For example, Amazon.com assigns ratings to products based upon reviews provided by users (members) of the Amazon.com Web site. Additionally, the reviewers (members) are assigned ratings by the Web site based upon other members opinions of the usefulness of

the reviews. Such member ratings may be included in profile (preference) information of the members.

Further, the mechanism of the present invention may be used for other purposes in which communications between nodes are based on policies. For example, advertising, information or marketing materials may be sent to different nodes based on characteristics of the group. When payments are exchanged, a clearinghouse may be used to manage payments between members in a group. This clearinghouse may be located in a node that is part of the group or in some other group. Compensation may be collected for intellectual property distributed through the network. For example, a clearinghouse may be used to collect royalties for copyrighted music. In this scheme, the clearinghouse may also receive compensation for managing collections and payments.

It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media, such as a floppy disk, a hard disk drive, a RAM, CD-ROMs, DVD-ROMs, and transmission-type media, such as digital and analog communications links, wired or wireless communications links using transmission forms, such as, for example, radio frequency and light wave transmissions. The computer readable media may take the form of coded formats that are decoded for actual use in a particular data processing system.

The description of the present invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to

those of ordinary skill in the art. Although the depicted illustrations show the mechanism of the present invention embodied on a single server, this mechanism may be distributed through multiple data processing systems. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.